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ABSTRACT

Many students are not skilled "thinkers" or "problem solvers." Extensive research has been conducted to describe the mental processes involved in problem solving in the hope of establishing a theoretical basis for training students to become more adept at reasoning. Certain problems become evident, however, when reviewing literature for designing an appropriate program: categories of intellectual abilities and skills are void of operational definitions, theorists do not share standard terminology for naming the same processes, they do not clearly define levels of reasoning skills, and they do not agree on the distinction between reasoning skills and strategies required for their application. To create problem solving programs for curricula using the findings of research, one must first determine a set of reasoning patterns that combine in various ways to make up more complicated reasoning patterns--a procedure that would be greatly facilitated by a standard set of definitions and distinctions. Students need to practice a series of intellectual skills that prepares them for meaningful application on given problems involving a variety of concepts. They also need direct instruction in the strategies required to apply specific skills. If researchers would report findings with this in mind, the burden placed on educators would be greatly reduced. (HTH)

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Difficulty in Establishing Problem Solving Programs Within Regular Curriculums

by

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Difficulty in Establishing Problem Solving Programs within Regular Curriculums

Introduction

It has become apparent to many educators as well as the American public that students in today's schools, to put it simplistically, are often able to memorize facts, but are not skilled "thinkers" or "problem solvers." A great deal of concern over this fact has been expressed any number of times in our newspapers and magazines and concurrently in highly scientific journals. An extensive amount of research has been conducted recently to investigate this aspect of human functioning in order to describe the mental processes involved in problem solving. Given adequate descriptions it has been hoped to establish a theoretical basis for training students to become more adept in applying reasoning skills.

Problems Encountered

Certain problems are encountered, however, when reviewing related literature and the findings of recent research to arrive at a theoretical basis for training students in reasoning skills in order to implement an appropriate program.

Operational Definitions

To thoroughly investigate related literature a traditional educator might begin with Bloom (2) and his taxonomy. When investigating Bloom's broad categories of intellectual abilities and skills, it is found that they refer to organized modes of operation and generalized techniques for dealing with materials and problems. Such categories as comprehension, application, analysis, synthesis, and evaluation are, however, intellectual capabilities void of operational definition. The same can be said of the "scientific approach" in terms of thinking processes: problem definition, theory construction, hypothesis derivation, hypothesis testing, experiment design, data analysis, and conclusion/evaluation. When considering the "rational powers" outlined by the Educational Policies Commission (3) 1961, one realizes that the "powers" described are not operationally defined. Until the 1960's behaviorists held full sway in the United States. They failed to distinguish, however, rote to meaningful from reception to discovery processes for presentation. Piaget's thinking then prevailed.

Critical Aspects of Skills Programs

Not only are operational definitions lacking or in some instances nebulous at best, but it becomes apparent when reviewing the literature that there is no standard set of terms used for designating certain processes; there is an unusually narrow range of problems which have been seriously investigated, since experimentalists mainly focus in areas of math and science; and few clear distinctions have been made between fundamental aspects of skills programs: levels of skills, skills vs. concepts, and skills vs. strategies. Piaget's theoretical basis is commonly employed for investigations of thinking, particularly formal operational reasoning described by Inhelder and Piaget (4). Levine and Linn (7) comment that this single-stranded notion of human rationality is exemplified by various problems basically of a scientific nature, for example, those requiring conservation of volume or weight, using proportions, and controlling variables. The wide variety and specificity of problem types, however, argues against understanding human problem solving in terms of a single conceptual scheme, such as the utilization of the forms of logic suggested by Piaget, or the small sets of general abilities mentioned above.

Novak (8) argues that Ausubel's theory of cognitive learning is more reliable and powerful for science and mathematics than Piaget's development psychology. Ausubel's basic concepts are: meaningful learning, subsumption, obliteration, progressive differentiation, integrative reconciliation, and advance organizers. In contrast, Piaget conceives of the following stages: sensory-motor (birth-2 years); preoperational (2-7); concrete operational (7-11); and formal operational (11+). Ausubel (1) saw no stages of cognitive development in studies he examined. Instead, he saw cognitive development as most idiosyncratic and concept specific. He contended that teaching grand heuristics for problem solving or formal operational thought will not demonstrate any substantial transfer value; therefore, educational effort should be made to present a hierarchically organized framework of concepts.

Lawton, Saunders and Muhs (6:131) thoroughly compare and contrast theories of Piaget, Bruner and Ausubel. In discussing implications for education they wrote: "Each theory recommends a set of permissible value systems (either explicitly or implicitly), eliminates some values and goals as simply inappropriate, and denounces others as actually detrimental to the best interests of the developing intellect."

Karplus (5:152) even relates that, "At the present time we do not envisage a "fundamental" set of reasoning patterns that combine in various ways to make up more complicated reasoning processes--empirical research will have to reveal whether and how different reasoning patterns are related."

Solution

The process of establishing a "fundamental" set of reasoning patterns using empirical research to provide the much needed direction seems to be retarded by the manner of reporting conducted by the theorists. At this time, to summarize, it seems clear that theorists conducting investigations in the area of problem solving do not share standard terminology for naming the same processes; they do not conduct research in a wide range of areas so generalization of results is limited; they do not clearly define levels of reasoning skills; nor do they make a clear distinction between broad categories of reasoning skills and concepts (content related); in addition, they have not reached concurrence regarding the distinction between reasoning skills and strategies required for their application.

Reading specialists, using a standard nomenclature, have defined specific levels of skills. They teach application of skills using material from various content areas. They also make a distinction between skills and content, involving specific concepts, in which skills are applied. Additionally, they make a clear distinction between skills per se and strategies or identifiable and reproducible thought processes directed at a particular type of task.

In order to create problem solving programs for curriculums using the findings of research, it is imperative that one first determine a set of reasoning patterns that combine in various ways to make up more complicated reasoning patterns. This procedure would be greatly facilitated if those conducting the investigations and reporting the results would adopt a standard set of definitions and distinctions and utilize them when reporting results. In addition, they should bear in mind when experimenting and reporting that educators such as reading and learning specialists who work with students will read this material for information. It is anticipated that students need to practice a sequential series of intellectual skills, gradually increasing in difficulty, which prepares them for, and with guided instruction, leads them into independent, meaningful application on

given problems involving a variety of concepts. For adequate application students must have a background or an adequate storehouse of concepts required by or involved in the type of problems they attempt to solve or they will not be able to arrive at solutions. Furthermore, students need direct instruction in the strategies required to apply specific skills. If researchers would report findings with this in mind the burden placed on educators would be greatly reduced.

As in reading, however, teaching these strategies in an isolated fashion, i.e., becoming too "strategy oriented" without providing for their application in appropriate material containing a variety of problems would be useless. Therefore, sufficient material needs to be made available for frequent application. Some of this material must contain problems from all relevant content areas.

In order that sound problem solving programs can be implemented in today's schools then, results of research need to be reported with the educator in mind. Educators could then attain from the literature the level and sequential order of skills in question, as distinguished from concepts, and specify the strategies required for their application. Subsequently, they could locate materials, and many are now available, or create appropriate exercises for teaching these strategies in order to provide sufficient application, thereby ensuring the transfer value of their efforts. Much information seems to be presently available. Sorting through innumerous articles to synthesize findings at this point is at the present time a herculean task, however, because of the tremendous semantic burden placed on the reader due to the various sets of terms used, the narrow range of problems researched, and the confusion that seems to exist over level of skills, skills vs. concepts, and skills vs. strategies.

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